Innovation in Tasmania

AN INNOVATON CENSUS IN AN AUSTRALIAN STATE

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Tasmanian Innovation Census Working Paper Series
TIC/0108

Innovation in Tasmania
An innovation census in an Australian State

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22 July 2008

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SUMMARY

Tasmania’s Department of Economic Development and Tourism is responsible for Research and Development (R&D) policy and innovation support to Tasmanian firms. A big priority of the Department has been to improve our understanding of innovation in Tasmania – what is the real extent of innovation in the Tasmanian economy, and what does it consist of? So it funded the Australian Innovation Research Centre (AIRC) at the University of Tasmania to find out. The result is the *Tasmanian Innovation Census*, a unique map of innovation across all Tasmanian firms. This first report on the Census presents a broad overview of the initial results.

The Census consists of a detailed company level survey of innovation activity in Tasmania, looking at the development of new products and the implementation of new processes and organisational forms. It is unique among innovation surveys in that it covers all sectors of the economy and all firms with five or more employees. It sought a comprehensive view of Tasmania, including coverage of such sectors as agriculture, horticulture, mining, and fishing, which are often excluded from national innovation surveys. The total number of firms in the population database was 2807, of which 1591 responded (a response rate of 56.7%).

The results may surprise those who think that Tasmania is non-innovative. The main conclusions are:

- Tasmania is not a low-innovation economy. Innovation is pervasive across the Tasmanian economy, with high proportions of innovating firms and little inter-industry variation in the extent of innovation activity.
- A high proportion of firms earn revenue from new or significantly changed products.
- Firms invest extensively in a wide range of innovation inputs – not just R&D, but in design, new capital goods for innovation, marketing activities and skills and training.
- Although innovation is broadly based in Tasmania, the intensity of innovation is very uneven. The proportion of highly-innovative firms is low: a relatively small group of firm’s accounts for most of the sales of innovative products and most of innovation investment.
- ‘Soft’ innovations relating to skills, training, human resources, work organisation, business practices, and management methods are important areas of innovative activity.

- Diffusion of Information and Communication Technology (ICT) remains a major innovation activity, with big research efforts in ICT, especially outside the ICT sector itself.
- R&D is widely performed, covering all application areas and fields of science and technology; service industries have particularly high levels of R&D in their innovation expenditures. But around 35% of all innovation-active firms are innovating without doing any R&D at all.
- Innovation-oriented collaboration is widespread, including with universities. 142 innovation-active firms have collaborative links with the regional university, the University of Tasmania (UTAS): this suggests a much stronger role for UTAS in the regional economy than has been previously realised.
- Tasmanian firms collaborate also with firms and universities outside the region, both nationally and globally.

The questionnaire followed the broad guidelines provided by the OECD and Eurostat for such surveys, and covered the following issues:

- Expenditures on different categories of innovation activities (including R&D, design, acquisition of capital goods, training, acquisition of external knowledge, and activities for the market preparation and introduction of product innovations).
- Development and sales of new products, and data on proportions of sales deriving from new and changed products.
- Organisational change.
- R&D performance in innovating firms in Tasmania, broken down by objectives and fields of research.
- The extent and types of collaborative behaviour in innovation processes.
- Qualitative information of key innovation outputs and projects among firms.

The survey was conducted by the CATI technique (that is, Computer-Aided Telephone Interviews). It has been a three-year project. Year 1, in 2006 involved questionnaire design, construction of the population frame (consisting of a database of all Tasmanian firms with more than 5 employees), pilot survey testing and implementation. Year 2, in 2007, saw full survey implementation, and construction of a results database, while Year 3 (in 2008) has involved data processing and analysis, then reports on survey results, case studies, and policy analyses.

In the breadth of its coverage, Tasmanian policymakers now have access to a resource that is unique in Australia and possibly in the world. This is a rich dataset, which we hope will drive research and inform policy and public debate in the months and years ahead in Tasmania. Current projects already underway with the data include work on ICT and innovation in Tasmania; skills, training and innovation; innovation and logistics planning; and innovation in tourism. Future project work will explore university-industry interactions in Tasmania and the links between innovation and firm performance (in terms of sales, employment and export growth).

Introduction

Tasmania is a small, remote, beautiful island with around half a million people and an economy heavily reliant on resource-based industries, low-tech activities and services. In a world increasingly dominated by innovation and new technologies, how can such an economy survive and prosper? How much innovation occurs in this kind of economy, and what does it look like?

The view that Tasmania is a low-innovation economy is widespread. In the Australian Bureau of Statistics (ABS) 2005 national innovation survey Tasmania ranked the second lowest of all States and Territories in terms of the proportion of businesses innovating, while Tasmania ranked lowest in terms of the proportion of total expenditure on R&D in 2005/2006 ABS data.[1] These kinds of results are linked with public perceptions. In early 2008, Tasmania's Department of Primary Industries released results of a survey of 1500 visitors to Tasmania, seeking opinions on tourist experiences. One headline result was that 'Tasmania was not perceived as being a place of innovation'.[2]

But are these views and perceptions true? How innovative - and therefore how dynamic - is the Tasmanian economy in reality, and what are the implications for Tasmania's Government? This report seeks to answer these questions. It rests on a large-scale detailed survey of firms in Tasmania. In our view, too many opinions about Tasmania's performance rest on preconceived ideas, partial evidence, misleading examples, and plain bias. We sought to go beyond all that: within a systematic survey framework we have looked at *all* firms, not just some, *all* industries (not just those alleged to be highly innovative), and *all* localities. In other words, we have not performed a survey, but have attempted a census. We gathered financial and employment data, and produced direct measures of innovation inputs and outputs, plus data on collaboration and specific important innovations. The data permits a detailed yet economy-wide view of how much innovation happens in Tasmania.

To some, the conclusions we reach may be surprising. We show that Tasmania, far from being a rural backwater, is highly innovative. All parts of the economy are innovative: innovation activity is strongly present across all sectors and industries. Firms invest heavily in

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[1] 8158.0 Innovation in Australian Business 2005, 8140.0 Research and Experimental Development, Businesses 2005/2006.

[2] Philippa Duncan, 'What's wrong with Tassie. Visitors point out our faults', *The Mercury*, March 26, 2008.

innovation, they introduce and market new products, they do surprising amounts of R&D, they collaborate with other firms and with universities and research institutes and they deploy advanced technologies. They are active in the whole gamut of innovation-relevant activities. But the data also reveals continuing policy challenges, and opens up important but unresolved questions for the future.

How can we explore and measure innovation? And what did we ask?

Innovation is based on qualitative change: new ways of producing products, new performance characteristics in products themselves, new materials for making things, and new services and organisations. This ‘newness’ raises serious problems for any attempt to measure change; because measuring usually means that we are quantifying similar things. By definition innovation means difference and novelty, and so it cannot be measured directly. How then can we gather meaningful quantitative data?

Our approach is not based on asking firms about ‘innovation’, a term that is easy to misunderstand. Indeed the word ‘innovation’ occurs at only one significant point, at the conclusion of our survey questionnaire. Instead, we focused on asking firms about changes in their product mix: did they develop or change the technologies of their existing products or services? Did they introduce new products, and if so, how new were they? Then we asked about how they produced their outputs: did they change the technologies of their production processes or their business organisation? If firms changed their product mix, then we sought to measure their economic impacts on the firm. To do this we asked them to estimate the extent to which their sales depended on new or changed products or services. In other words, we asked for an economic measure of innovation output: what proportion of the sales of the firm derived from changed or new products?

We took a broad view of innovation. In our definitions, product innovation includes relatively minor upgrades in existing products and services (as long as the performance improvement is a significant one and not just cosmetic), the introduction of products that are new for the firm (but not necessarily new for the market), as well as products new to the market. Likewise process change need not involve wholesale change, but can also mean upgrades to existing processes. From this perspective, innovation involves novelty and learning for the firm, but not necessarily for the system as a whole. The point of taking this view is that the economic impacts of innovation happen not just through the first introduction of an innovation, but also through processes of spread, adoption and upgrading. "Innovation" can be defined very broadly. In technical literature innovation is defined as doing something new, usually on the basis of new knowledge. This can, however, be further defined as new products or processes, new structures of organisation, or new knowledge of physical processes. Many aspects of the innovation process do not lend themselves to measurement, or are extremely difficult to measure. Innovation can in a broad sense be compared with economic concepts such as "utility" or "welfare": they are subjective, not open to comparison or direct measurement. This does not mean, however, that all aspects of innovation are impossible to measure, or that we cannot find reasonable quantitative indicators. This is particularly true in the case of new products; they have a real existence, they can be identified by firms in their overall product-range and their sale can be estimated, often with a high degree of accuracy. As one of the most important objectives of this investigation was to obtain economic information about innovations, the survey concentrated primarily on this aspect of innovation - sales of new and significantly changed products.

The data from the investigation is based on three basic concepts: a definition of *technology*, a definition of *innovation* and a definition of two types of *new products*. Technology is defined as "knowledge, skills, competence and equipment" necessary for the development and/or manufacturing of a product. We say that an innovation has been carried out when "a new or modified product is introduced on to the market, or when a new or modified process is employed in commercial production".

But to generate innovations firms have to invest. They have to create tangible and intangible assets: new knowledge, new equipment, and new skills, which are the bases of innovation. We outlined a set of such activities, and asked firms whether they invested in them, and if so how much. This made it possible for us to compute measures of innovation investment expenditure, and to compare these measures across firms and industries. So we are able to look at overall innovation investment, its composition, and the way it is distributed among firms. One of these investment areas was Research and Development (R&D), and we asked firms not only whether they spend money on R&D, and how much was involved, but also about the application areas of their R&D, and the scientific or technological fields of research in which they were engaged. A further component of investing in innovation is collaboration. Innovating firms often need access to knowledge from outside the firm – they need access to capabilities that they themselves do not necessarily possess. So they collaborate with customers, with suppliers, and even with competitors. They also collaborate with scientific and technological institutions such as CSIRO or the university system. We gathered data on participation in such collaboration and then on location of collaboration partners, to get a sense of how Tasmanian firms interact and with whom. So the overall data gathering exercise covered:

- Ownership structures and location
- Sales over time
- Employment over time
- New product and service sales
- Organisational and managerial innovation
- Investments in innovation-related activities
- R&D by volume, objectives and fields
- Collaboration -partners and locations
- Most important innovations

The Tasmanian Innovation Census: what was done, and how the data was gathered

Innovation surveys are not new. They have been carried out in a number of countries since the late 1980s, and in a systematic way in the EU, in Canada and in Australia since the early 1990s. The largest such survey is the EU's *Community Innovation Survey* (CIS), which is administered every three years and covers approximately 100,000 firms in all EU Member States.[3] The Tasmanian Innovation Census drew on the CIS approach and was intended to be broadly compatible with it.

However the Tasmanian Innovation Census has four unique aspects, which distinguish it from all other innovation surveys that have been carried out hitherto. They are:

- It is not a sample survey but a census of all firms with 5 or more employees: that is, it rests not on a survey of a sample of the firm population, but on coverage of *all* firms.
- Because it is a census, by definition it also covers all industries and all economic activities. Previous surveys have focused on manufacturing and parts of the service sector, with some coverage of utilities etc. But the Tasmanian Innovation Census covers agriculture, horticulture, forestry, and mining - industries that are

[3] For an overview of methods and results of these surveys, see K. Smith, 'Measuring Innovation', in J. Fagerberg, D. Mowery and R. Nelson, *The Oxford Handbook of Innovation* (Oxford: OUP) 2004, pp.148-177

very important to Tasmania, but that have not been in focus in previous innovation surveys.

- The Tasmanian Innovation Census was not a mail survey, but was conducted via telephone interviews. This meant that it was possible to interact with respondents, in order to clarify objectives and definitions.
- Finally, we collected not only quantitative data, but also an important piece of qualitative information. At the end of the interview, firms were invited to describe, in their own words, the 'most important innovation'. No guidelines were offered or constraints put on this – firms could say what they liked. This question permits unique insights into what firms actually do when innovating.

The research effort has taken three years, beginning in 2006. It involved three major steps. First was creating a 'population frame', meaning a database of all firms in Tasmania with 5 or more employees. Second was developing and testing a 'survey instrument', meaning a questionnaire. Third was collecting the data itself, which involved telephone contacts with approximately 2,800 firms. Finally, the data was cleaned, edited and analysed. The analytical effort is continuing.

The population frame was constructed through four main activities:[4]

- By using and integrating existing databases (such as Dun and Bradstreet, and the Department of Economic Development's 'BizTas' database).
- By using Yellow and White Pages business listings.
- By contacting all business associations and Chambers of Commerce, and requesting membership lists.
- By 'legwork': travelling through Tasmanian towns, cities, industrial zones, and rural localities, seeking firms that might otherwise have not been identified.

These activities led to a database of approximately 4,500 firms. Subsequent investigation showed that about 1,700 of these firms were ineligible because they were out of scope: dead, not trading, duplicates, or had less than 5 employees. This left us with a population of 2,807 firms that were surveyed.

[4] We would like to thank Alexandra Lejda for her work with Sophie Jerrim on building this database.

The questionnaire was field tested in early 2007, on approximately 60 firms in the Coal River Valley area. This led to a number of revisions to the questionnaire, but also showed that the questionnaire was understandable by the respondents, and could be administered in a reasonable time – not more than 20 minutes.

The main data collection began in August 2007, by a Hobart-based firm, Enterprise Marketing and Research Services (EMRS), under the leadership of Tony Hocking.[5] Data collection and input was completed in January 2008. EMRS also later conducted a separate survey of firms who had not responded to the initial census questionnaire, to explore the possibility of 'response bias' (that is, disproportionate responses – specifically whether innovating firms were more likely to respond than non-innovating firms). The ABS Tasmanian Office assisted us, via a statistical consultancy, in the sampling and design of the non-response survey. For the census as a whole, firms were guaranteed anonymity and confidentiality. Responses were used to populate a large-scale innovation database. Data analysis began in early 2008.

Responses

We achieved a good response rate: firms were positive to the survey, and often very generous with their time and thoughts. The total in-scope population was 2,807 firms, of whom 1,591 responded with usable data, a response rate of 56.7%. Most of the respondents were small, as Table 1 shows - 87.2% of respondents had less than 50 employees.

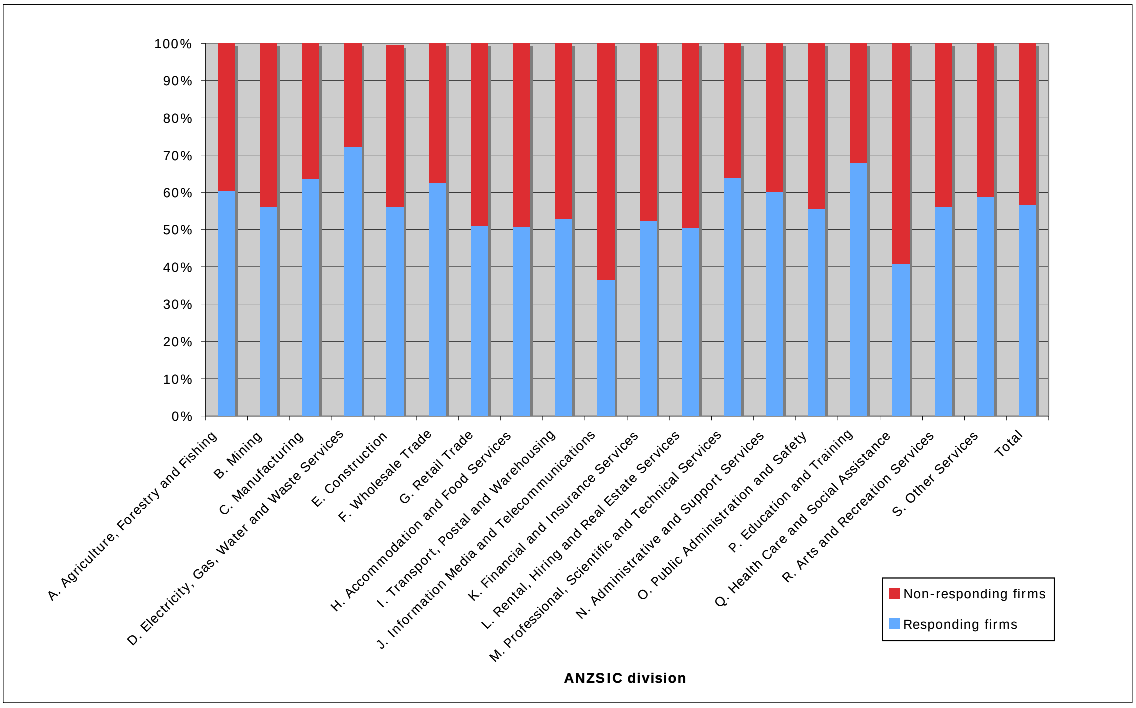
Table 1: Responses by firm-size category

Firm size category	**No. of responding firms**	**Proportion of responding firms (%)**
5-9 FTE	599	37.6
10-19 FTE	465	29.2
20-49 FTE	323	20.3
50-99 FTE	108	6.8
100-249 FTE	62	3.9
250+ FTE	34	2.1
All responding firms	1591	100.0

[5] We would particularly like to thank Sam Paske and Anna Lethborg of EMRS for their work on data collection.

The response rates did not vary significantly across industries, as Figure 1 shows. So the project of undertaking a census did in fact lead to responses across the whole gamut of Tasmanian industries.

Figure 1: Response rates by industry



Here, the standard deviation around the overall response rate is 8.63%, implying a very low coefficient of variation of 0.15. So we have good industry coverage.

Similarity in response rates is important because it suggests that our distribution of firms is representative: the distribution of respondents by industry accords with the distribution of those industries in the economy as a whole. Figures 2 and 3 show the response structure by industry, and the industry population respectively – it can be seen just by inspection that these distributions are remarkably similar. So we have a representative picture of the Tasmanian economy in the responses.

Figure 2: Proportions of responding firms by industry

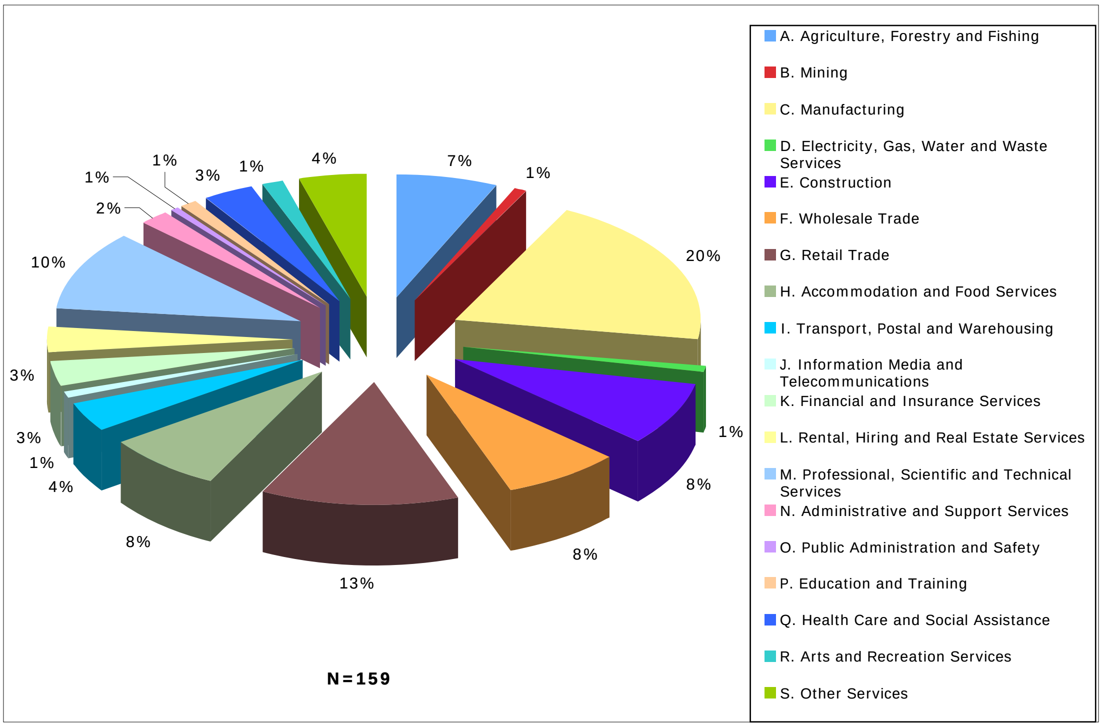
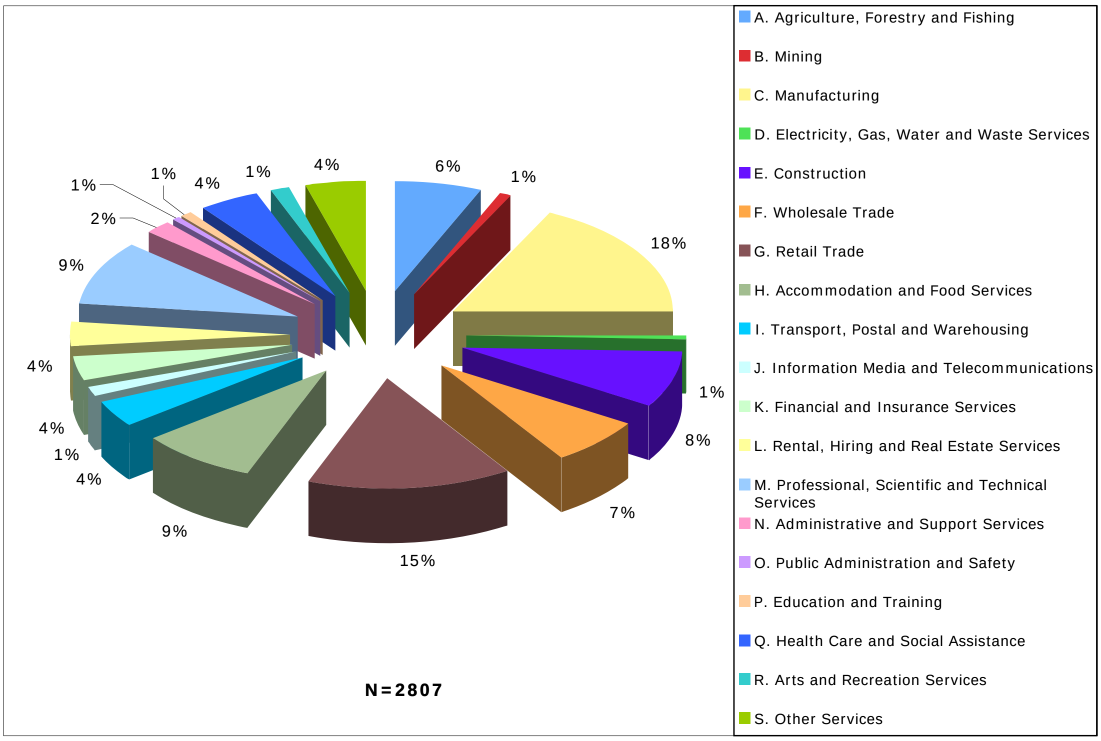


Figure 3: All firms by industry



We also surveyed, or more accurately re-surveyed, firms who had not responded to the original survey, either because they refused, or were uncontactable. The objective here was to explore whether innovating firms were more likely to respond to the survey. Results from this survey are relevant in the next section, and will be discussed there.

INNOVATION-ACTIVE FIRMS IN TASMANIA

How many firms innovate, what proportion of the whole are innovators, and how are they distributed across industries? To answer this we first need to define what an 'innovation-active' firm actually is. We defined an 'innovation active' firm as one that either:

- Introduced a new or significantly improved *good or service* in 2004-2006

Or

- Introduced a new or significantly improved *process* in 2004-2006

This definition excludes a small proportion of firms that were spending money on innovation-related activities (such as design, or R&D or equipment acquisition) but had not yet actually undertaken change. We were looking for firms who had actually implemented new products or processes.

According to our definition, a very high proportion of firms are 'innovation active' – just over 70%. Innovation activity, as defined above, is very broadly distributed in Tasmania.

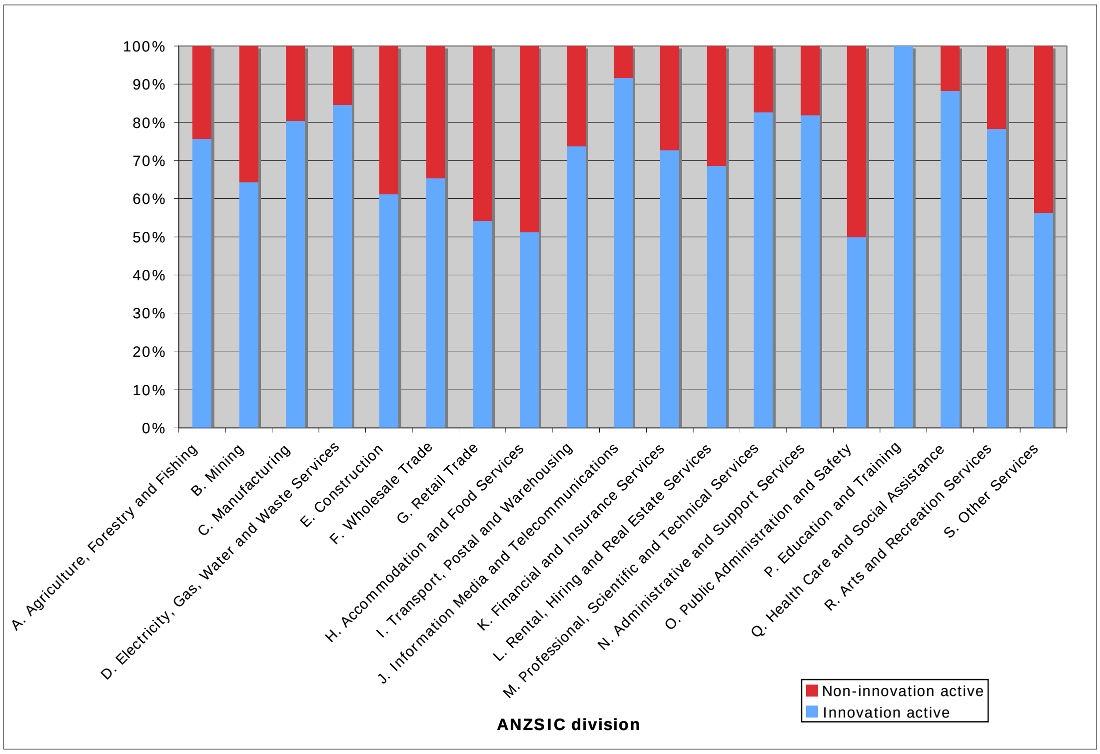
Table 2 shows the basic data for all firms classified by size class.

Table 2: Innovation-active firms in Tasmania

	Innovation active		**Non-innovation active**		**Total responding firms**
Firm category	**N**	**%**	**N**	**%**	**N**
5-9 FTE	392	65.4	207	34.6	599
10-19 FTE	315	67.7	150	32.3	465
20-49 FTE	239	74.0	84	26.0	323
50-99 FTE	86	79.6	22	20.4	108
100-249 FTE	53	85.5	9	14.5	62
250+ FTE	30	88.2	4	11.8	34
All responding firms, N=1591	1115	**70.1**	476	29.9	1591
Non-response sample, N=94	68	72.3	26	27.7	94

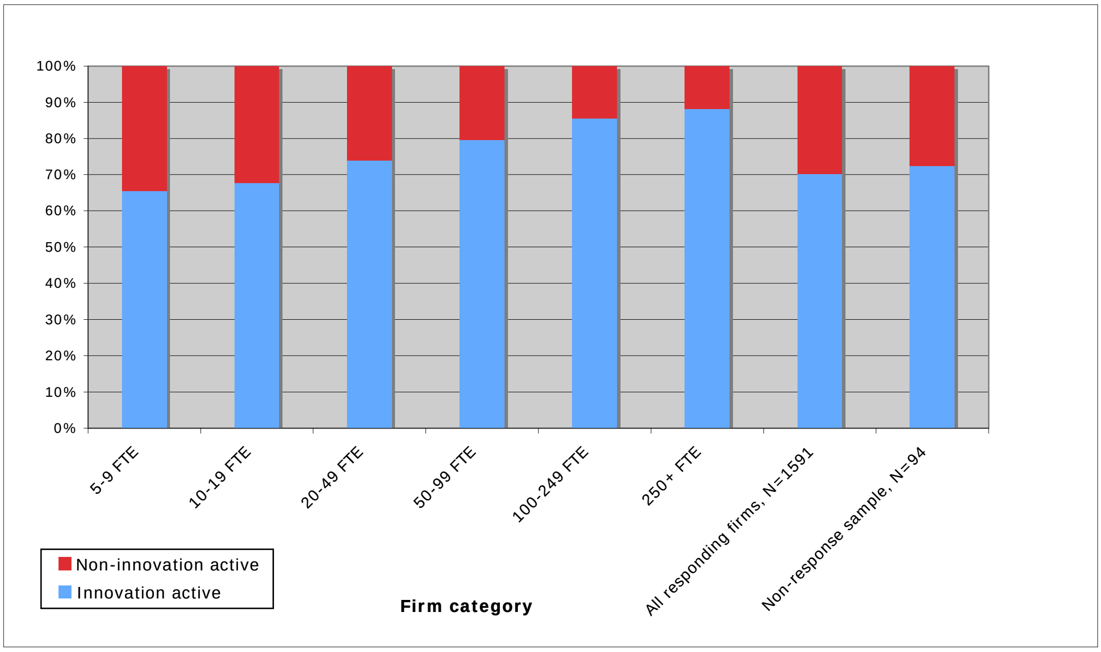
Before we discuss these very high numbers, it is worth looking at the distribution of innovation activity across industries. Is it the case that some industries are far more innovative than others, in terms of innovation-active firms?

Figure 4: Innovation-active firms by industry



What this figure suggests is that innovation is widely distributed across industries in Tasmania: it is in fact pervasive, and certainly not a matter of one or two highly innovative activities. The statistical evidence for this is that variation around the mean of 70.1% can be seen to be quite low (the standard deviation is 14.2%, and the coefficient of variation is 0.2). Innovation occurs across all sectors, even such traditional activities as agriculture, construction, and transport. It also occurs across all firm-size categories, with innovation activity increasing as firms sizes grow.

Figure 5: Innovation active firms by firm size



Innovation activity rises steadily with firm size, a well-known phenomenon in innovation research, and something consistent with other innovation surveys. But the important things for Tasmania are probably the high basic level of innovation activity among small firms, because these are by far the most prevalent in Tasmania.

Why does Tasmania have so many innovation-active firms?

This proportion of innovation-active firms is very high - very much higher than the ABS national innovation survey found for Tasmania, and generally higher than countries or regions taking part in the EU's *Community Innovation Survey*. Why such a high result for Tasmania? Have we made a statistical or methodological error here?

There are two potential statistical/methodological errors we could have made, and two methodological differences that might have had an impact. We believe that only one of these could account for the difference we found, and that it would support the accuracy of our data.

On the statistical side of things there might be two mistakes. First, we might have more or less severe response bias. That is, the firms which responded were not the same as the firms which did not respond – if respondents were more likely to be innovation-active, and then we would end up with a higher proportion of innovative firms in the result. We checked this through our separate survey of non-respondents. The non-response analysis - which was designed with the expert assistance of the ABS - sampled 94 firms with broadly the same industry proportions as the main census. The non-response survey included three simple questions to ascertain whether a firm introduced new products or processes during the reference period, and whether new products or processes were planned to be introduced in the future. The result was that the non-respondents actually had a *higher* proportion of innovative firms (see the bottom line of Table 2 above). So we believe we can dismiss response bias as a cause of the high proportion of innovation-active firms. A second statistical possibility would be sampling error - that is, our sample is seriously biased and does not represent the population. But this can hardly be the case, since we have not done a sample survey at all: our sampling frame is as identical to the total population as we can get it. So we can dismiss sampling error.

Beyond these statistical issues are possible differences in definitions, and in collection methods. However our definitions of innovation are essentially the same as those used by the ABS in the Australian innovation survey, and to the EU Member States in the Community Innovation Survey. These definitions follow from the OECD's *Innovation Manual* (the 'Oslo Manual'), and are commonly used in innovation surveys. So definitional differences cannot be a major source of difference in proportions of innovation-active firms.

This leaves collection methods, and here we have a real difference. Most innovation surveys are postal surveys, with a mailed questionnaire going to a sample of firms; in most cases these come from statistical offices and are compulsory. Questionnaires are usually accompanied by a set of definitions, but it is unclear the extent to which firms either read or understand the definitions. Our approach was to collect data with trained telephone interviewers. Interviewers were able to clarify with firms exactly what we meant by innovation. We were able to emphasize that it was not necessary to make radical changes to be an innovator. Small-scale change in products or services, incremental improvements in processes, and changes that were new only to the firm all constituted innovation. When first contacted, a number of firms suggested that they were not innovators, but then changed their minds when the concepts and definitions were clarified. We believe that interaction with interviewers goes a long way towards explaining why our proportion of innovation-active firms is high.

Census data quality measures – cleaning, editing, processing, coding – were extensive, and we have no reason to doubt the general accuracy of the data, and therefore the widespread character of innovation activity in Tasmania.

INNOVATION OUTCOMES AND ECONOMIC IMPACTS

We looked at innovation outcomes in terms of three broad categories: the introduction of significantly improved or wholly new products, the introduction of new or significantly improved production processes, and the introduction of new or significantly changed organisation and management systems. It is important to reiterate here that our definitions of innovation do not necessarily imply new inventions or radical changes. We are interested also in small-scale upgrades and improvement, in innovations, which involve adopting technologies that are new to a firm but not necessarily new to the market or world.

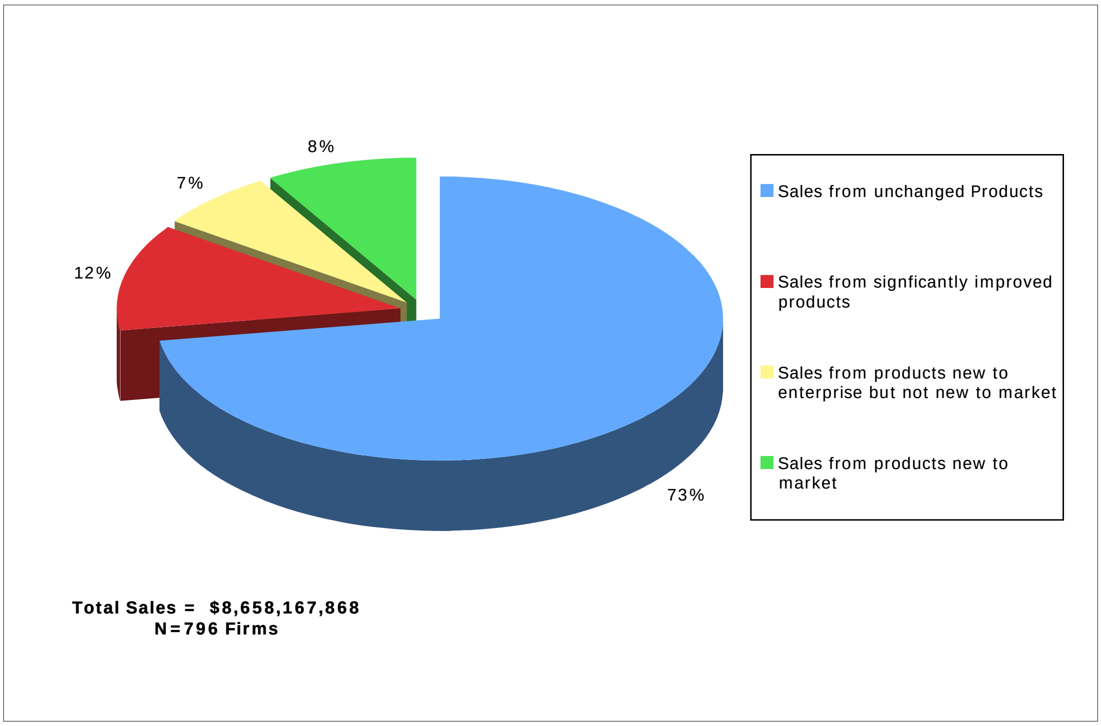
The economic effects of three types of change are shown in Table 3 and Figure 5. Each shows first, sales from products that are significantly improved, second from products that are wholly new to the firm, and finally products that are new to the market. The absolute value of sales from these companies, and the precise numerical breakdown of sales across the various categories of innovation are included. Although the question response rates were high, not all of the firms who responded were able to give detailed turnover figures, or to estimate their sales from different categories of new products and services. So our data in this figure covers all those firms who have product innovations, who offer turnover data, and who were able to estimate the shares; this is a total of 796 firms.

Table 3: Sales of innovative products and services

Sales from unchanged products	**Sales from significantly improved products**	**Sales from products new to enterprise but not new to market**	**Sales from products new to market**	**Total sales, N=796 firms**
$6,268,127,751	$1,078,304,459	$577,248,638	$734,487,021	$8,658,167,868

For these firms 27% of all sales flowed from products that had been innovated in some degree or another.

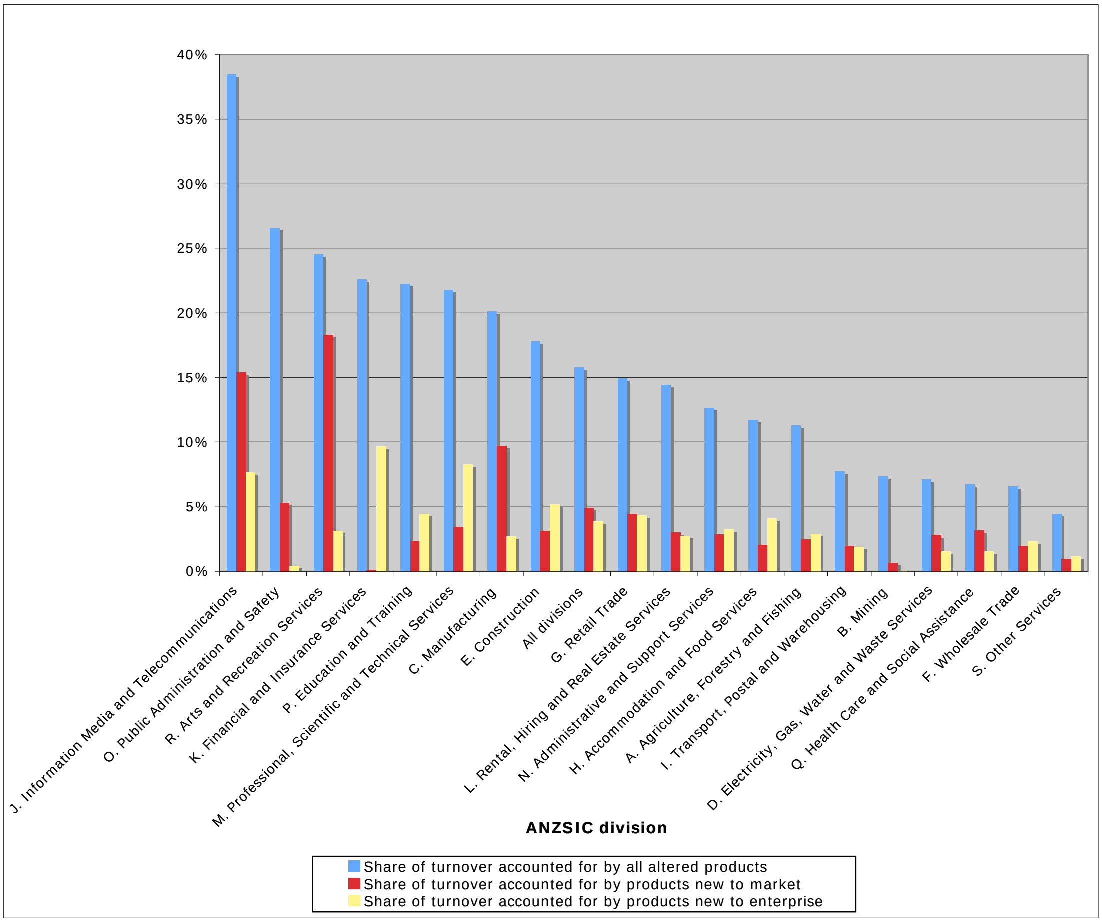
Figure 6: Sales of innovative products and services (%)



Once again, we face a difficulty in assessing this: is it a high or a low number? Certainly this suggests more innovation activity than emerged from the ABS national survey. It compares with a number of European countries, although cross-country comparisons with this type of data should be treated with caution. Even so, Figure 5 suggests a significant amount of sales being generated from innovations in products or services among these firms. We should bear in mind that these are products newly introduced over a recent three-year period, so this suggests quite a high level of change in the product mix.

There is however quite a large inter-industry dispersion among these sales, as Figure 7 shows.

Figure 7: Sales of innovative products by industry



Even so, sales of innovative products and services take place across all industries and reflect the pervasiveness of innovation activity shown in the previous section.

There are significant variations in the levels of turnover accounted for by innovations. The Information, Media and Telecoms industry in particular stands out, with a significantly larger share of its sales from new to market or altered products than the remaining industries, in all 40% of its turnover. ‘All altered products’ here includes sales from all three categories mentioned previously: significantly improved products, products new to the enterprise and products new to the market. The highest proportions of new products are not necessarily found in those industries which we normally term high-tech - although traditional industries come lower down on the list, we have quite high levels of innovation sales in financial services, manufacturing, and construction. Variations between the remaining industries (excluding electronics) are; however, relatively moderate, with most industries having more than 10% of sales deriving from all altered products. Thus we see that technological competition and innovation are not restricted to "high-tech" industries -

new and altered products make up a significant proportion of turnover in practically all industries.

When interpreting data of this sort, provision has to be made for the enormous differences in the product life-spans of different industries, with mining and electronics as examples of industries whose products have long and short life-spans respectively. This means that we must expect to find more frequent occurrence of new products in electronics, because their products have to be renewed relatively often. Industries such as metals produce well-established products for long periods of time. We cannot, therefore, directly compare the two industries, or judge one to be innovative rather than the other, on the basis of a comparison of shares of sales of new products. The innovative ability of individual firms is primarily related to what is happening internationally, in the same industry. A comparison of the innovation abilities of Tasmanian industries must therefore be made with comparable international data. This is a task for the future.

Another problem - also related to product life-span - is the time frame within which the launch of new products is studied. This survey is working with a three-year time frame, so the new products we are studying were launched in the three-year period 2004-2006. In industries with frequent product changes this time frame will manage to record most innovative firms. In industries with slow rates of product change it will be more haphazard whether new products are launched during the time frame given. This problem particularly affects the comparisons of small and large firms; there is a greater likelihood that a new product will be launched by a large firm (with many products) than by a small firm (with few products): this is why innovation activity rates increase with firm size. This problem is, however, particularly noticeable because this is a first-time investigation. Follow-up investigations will help to expand the time frame and give more reliable data on both development in the different industries, and the relationship between small and large firms.

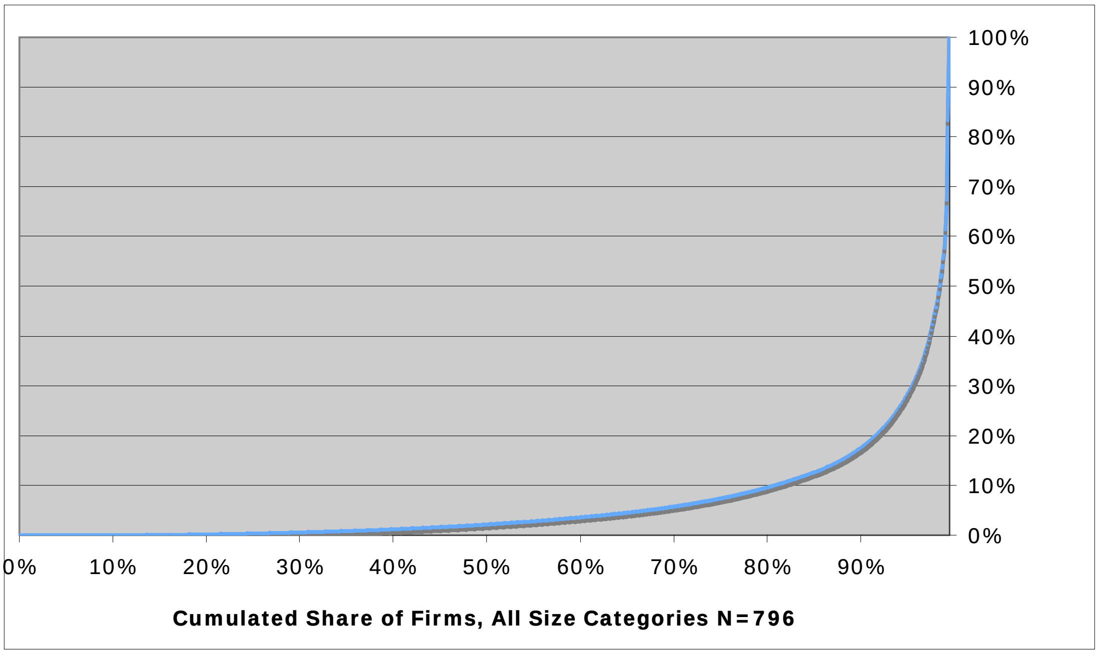
Although there is quite strong variation across industries, there is relatively little across different firm sizes: with the exception of ‘products new to the market’, where sales increase clearly with the size of firms, there appears to be no really striking trend across the firm size categories.

How uneven are innovation outputs?

We have shown that innovation activity is widely distributed in Tasmania, and that sales of innovative products are found across all industries, all firm-size categories and across many firms. But there is an important question about how evenly this activity is distributed. Is it the case that innovation outputs are being generated by large numbers of firms, or by only a small segment of the firm population?

We looked at this by constructing cumulative distributions of innovation sales. We ranked the firms by their sales of altered/innovated products (which includes significantly improved products, new to market and new to firm products), and then cumulated the sales to get the total sales of altered/innovated products. The results are shown in Figure 8 below.

Figure 8: Cumulated share of total turnover from all altered products, all firm sizes



What we have here is an extremely skewed distribution. Most of the innovating firms are actually contributing very little to the total sales of innovated products. The first fifty percent of the firms account for about three percent of total innovation sales. The final ten percent of the firms, however, account for more than eighty percent of innovation sales. In other words, although a lot of firms are earning money from new or significantly improved products, only a very small number are earning a lot: less than eighty firms in Tasmania account for more than eighty percent of all innovation sales. In fact about one percent of firms (i.e. eight firms) account for forty percent of innovation sales.

Given the way we have constructed this figure, an obvious possibility is that this is just an effect of different firm sizes: larger firms might have larger innovation sales, so our figure is just reflecting the fact that the top ten percent of firms are large. One simple way of checking this is to look at the cumulative distributions for different firm size categories. We do this below in Figures 9 to 14. What we see is that the uneven distribution is present in every firm size category - unevenness in innovation sales is not just an effect of different firm sizes.

Figure 9: Cumulated share of total turnover from all altered products, firms with 5-9 FTEs

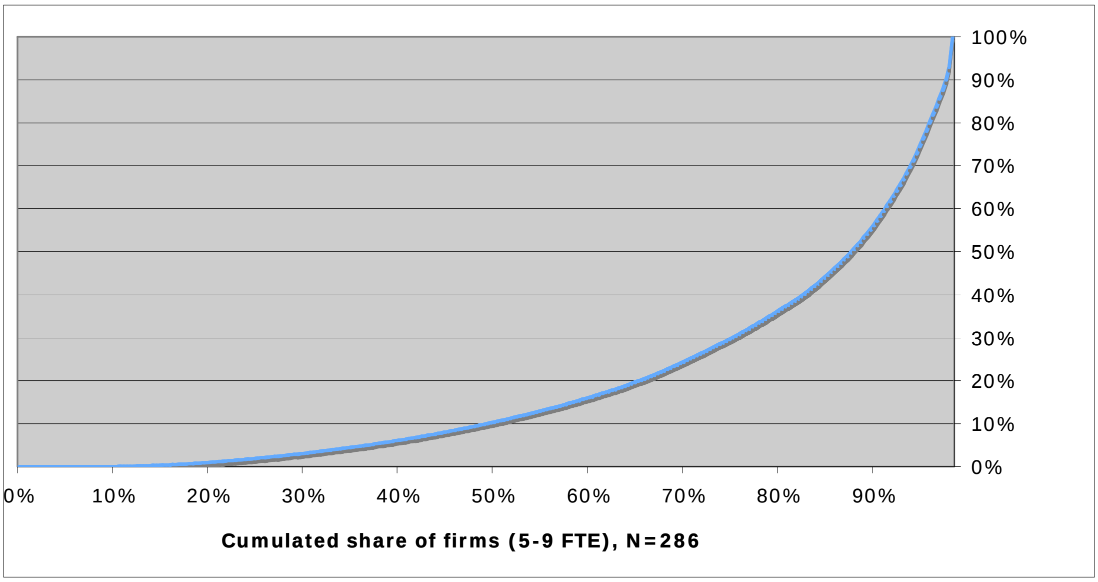


Figure 10: Cumulated share of total turnover from all altered products, firms with 10-19 FTEs

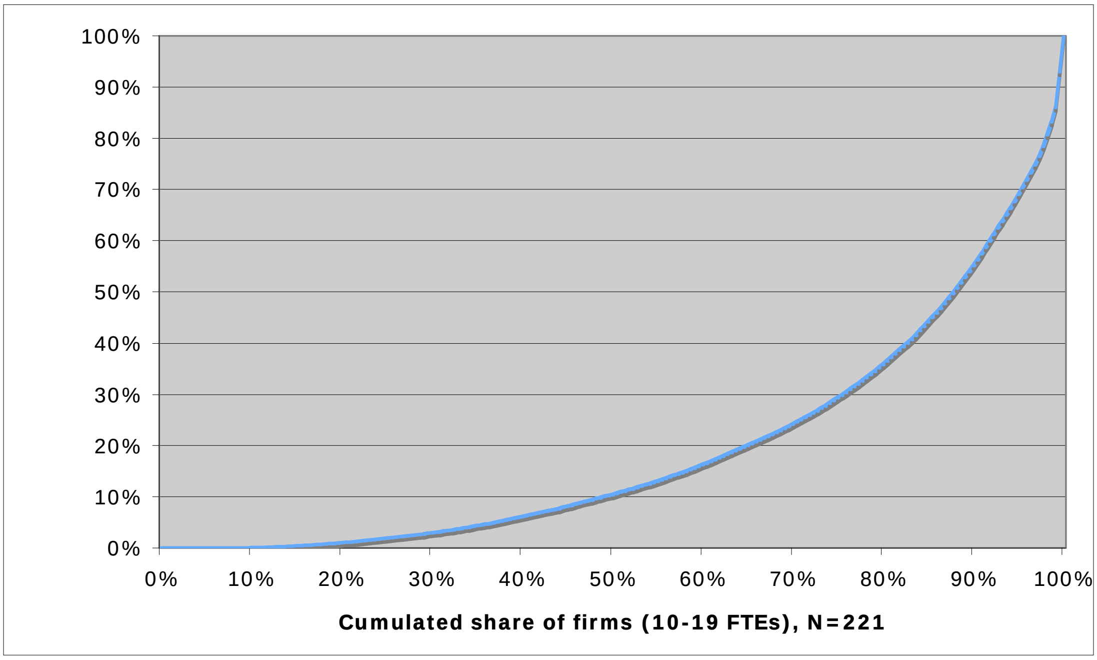


Figure 11: Cumulated share of total turnover from all altered products, firms with 20-49 FTEs

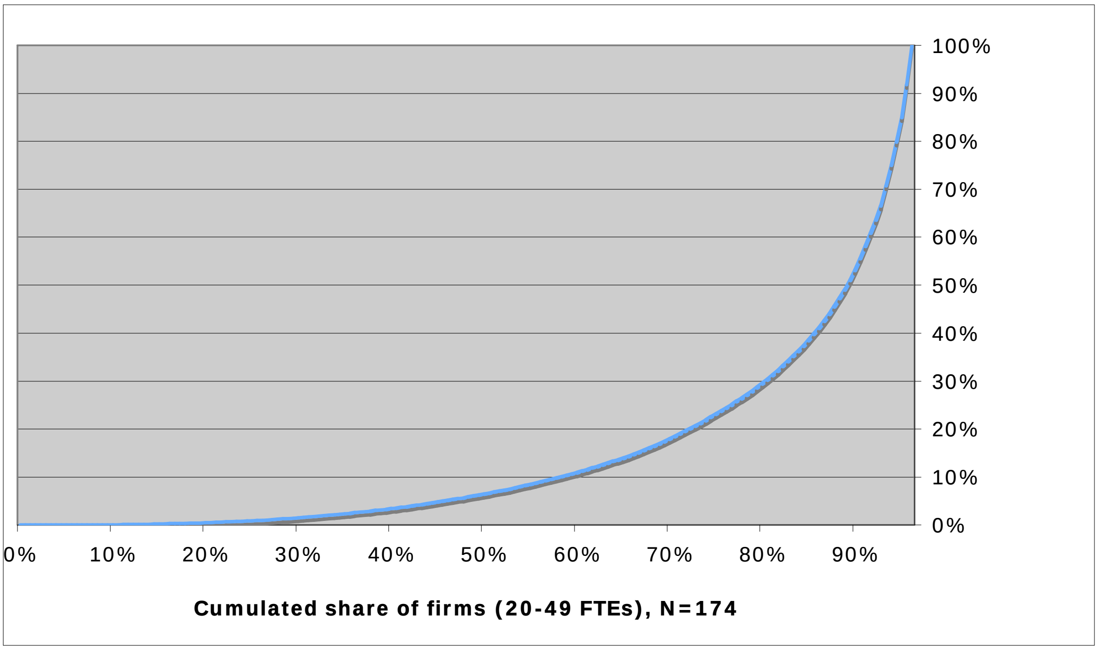


Figure 12: Cumulated share of total turnover from all altered products, firms with 50-99 FTEs

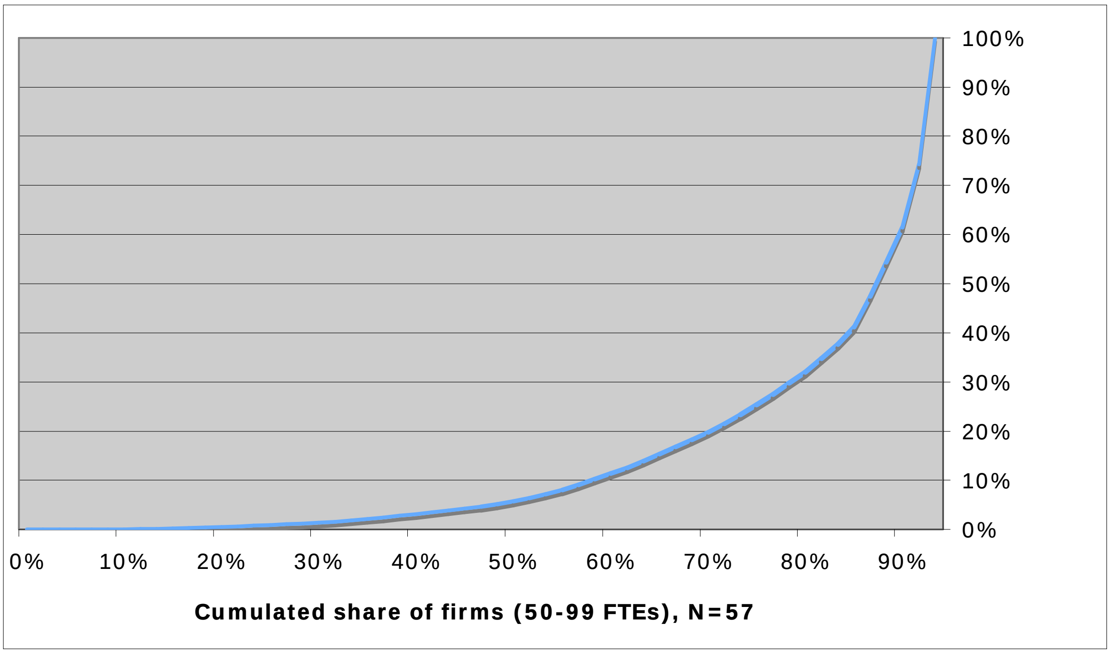


Figure 13: Cumulated share of total turnover from all altered products, firms with 100-249 FTEs

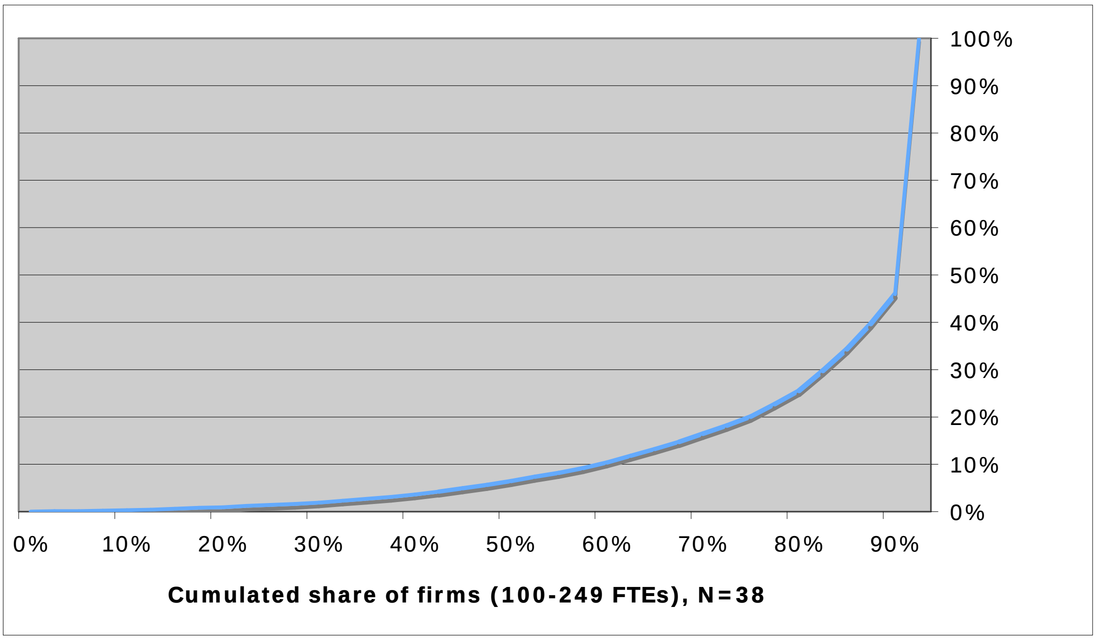
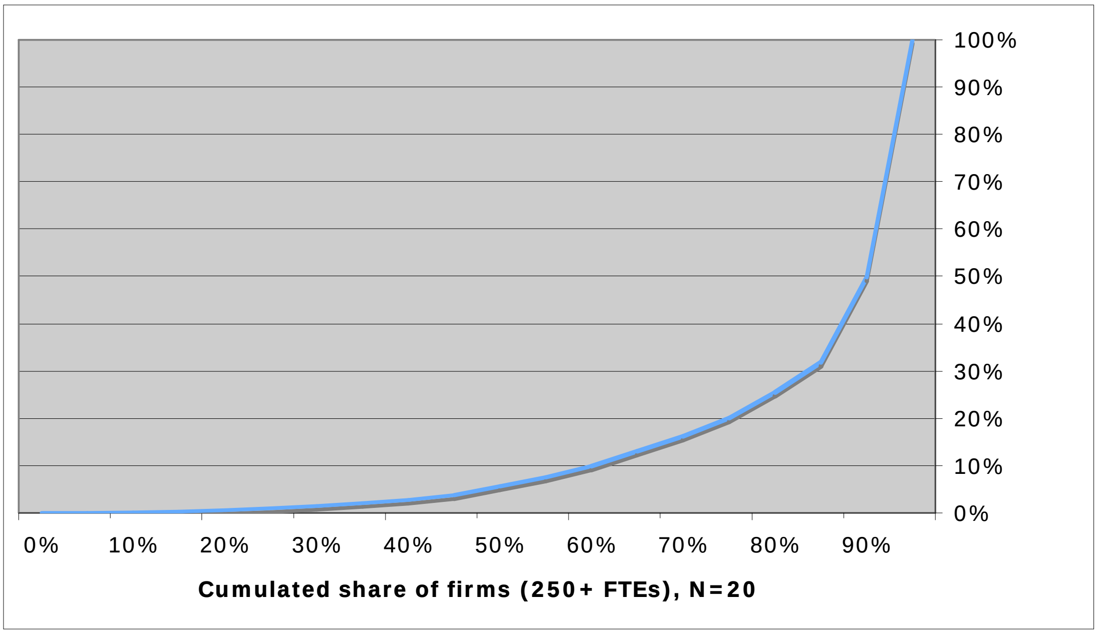


Figure 14: Cumulated share of total turnover from all altered products, firms with 250+ FTEs



What we have in each category is a small proportion of highly innovative firms. An important question, which we cannot answer at the moment, is whether these firms remain innovative over time, or whether the data reflects a recent burst of innovation activity. We would hypothesize that these firms are innovative over time, because case study evidence suggests that innovating enterprises usually produce not 'one-shot' innovations but rather a flow of innovations over time. If this is the case, an important policy question emerges. Should the main focus of policy be on lifting low-innovation firms to higher levels of performance, or should it be to help highly innovating firms grow bigger? If there is a case for policy support of firms, how should it be balanced between these types of firm?

INVESTING IN INNOVATION

This section describes the different types of investments made by firms during the innovation process. In the past, analysts have been restricted to using company R&D as more or less the sole indicator of innovation activity. However, it has always been clear that firms need to invest in a range of other activities in order to create innovations and to commercialise them. The OECD statistical manual outlining the collection of R&D data identifies six areas, which should not be covered by the term R&D. These are: Industrial engineering (tooling up), pre-production development, market analyses, investment in equipment, purchase of technological information and design. This list corresponds almost exactly with the type of innovation activity - other than R&D - emphasised in modern innovation theory, and which to an increasing degree is incorporated into those analyses. Many innovation theorists argue that for many industries R&D has been shown to have only marginal importance for the development of new products and processes.

The innovation survey questionnaire asks about many of the above-mentioned activities, including:

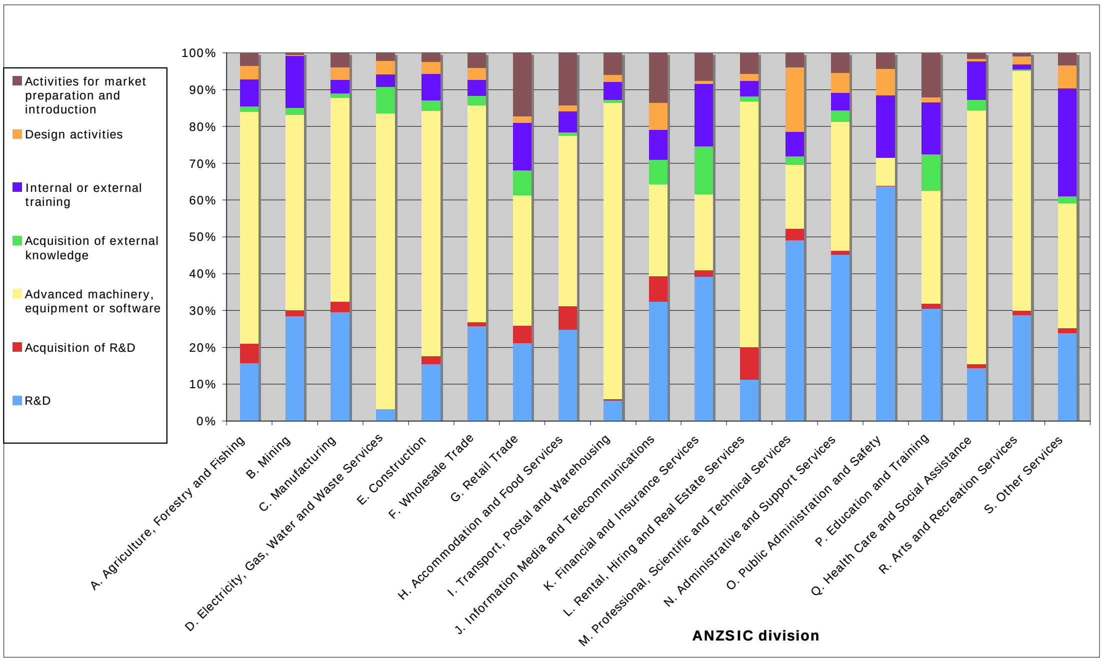
- R&D, both internal and “bought in”
- Design activities
- Internal or external training
- Purchase of patents and licences
- Market analyses and market preparation
- Purchase of capital good for innovation in products or processes

In addition, the questionnaire asks for information about *capital expenditure on innovation activities*: this is investment in advanced machinery and equipment, including computer hardware and software.

For these categories of expenditure it is often difficult for firms to provide exact figures, and so we asked for the best estimates that were available. Below we give an overview of the results and the relationships between the various cost components in each of the industries. Further, we look at the innovation investments of firms of different sizes. We find substantial differences between industries, as well as an uneven distribution of innovation investments between firms.

Figure 15 below shows the proportions of different types of innovation expenditure within each industry sector.

Figure 15: Composition of innovation expenditures by industry



Simply by inspection of the diagram we can see two important things. On the one hand, all industries perform many different types of activity when innovating. Innovation is not a matter of getting one key input right - it involves managing a number of different inputs, at different scales. Integrating these different types of activities is likely to be a major challenge for management; and all of them have risks and uncertainties attached. On the other hand, there is quite significant variation in the pattern of innovation investments across Tasmanian industry. The three largest components of innovation expenditures are R&D, capital expenditures, and training. We can make an immediate distinction between industries in terms of how they spend on these three categories.

The key points are as follows. First, there is a range of industries in which capital investment for innovation - the purchase of advanced equipment - is by far the biggest element of innovation expenditure. This group comprises what are often called ‘low-tech’ or ‘medium-tech’ industries: agriculture, mining, manufacturing, construction, wholesale and retail trade, transport and real estate services. These are all sectors producing innovation outputs in the form of new or improved products, and together they make up by far the largest proportion of the Tasmanian economy. The key point here is that we have a major sector of innovating industries that rely primarily on technologies that are accessed through the purchase of capital goods.

Secondly, when we turn to R&D, the industries using the largest proportions of R&D in their expenditure mix include one of what are conventionally called ‘high-tech’ sectors (information, media and telecommunications). The other big users of R&D are various types of services. Notable in this are financial and insurance services; professional, scientific and technical services; administrative and support services; and public administration and safety. R&D is also a significant part of the mix in other services: education and training, arts and recreation, and health care and social assistance. These are not at all the industries that are usually regarded as R&D-intensive. It’s worth noting that not only are they service industries, but many of them are closely related to public services and social services such as health and education.

Thirdly, training is a noteworthy component of innovation expenditures across a number of industries. There are six industries, five of them services, in which training makes up more than 10% of innovation expenditures: mining, retail trade, financial services, public administration and safety, education and training, and other services.

This quite significant difference between industries can readily be seen by comparing the breakdowns of innovation expenditures across two industries only:

Figure 16: Innovation expenditures, agriculture, forestry and fishing (%)

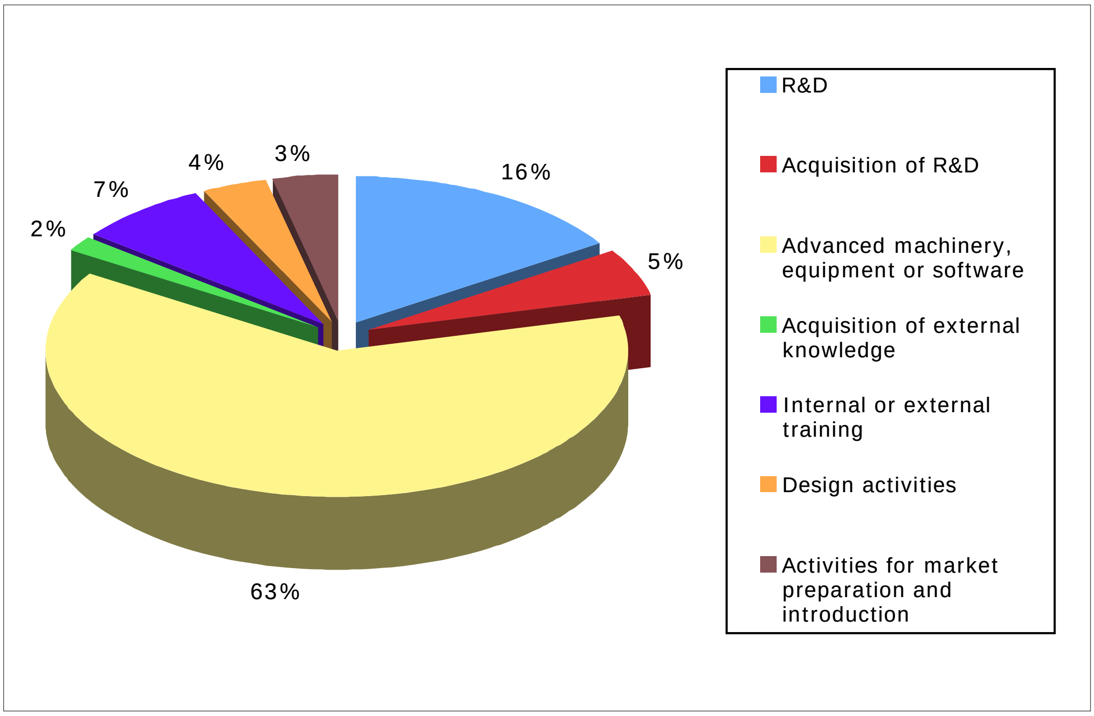
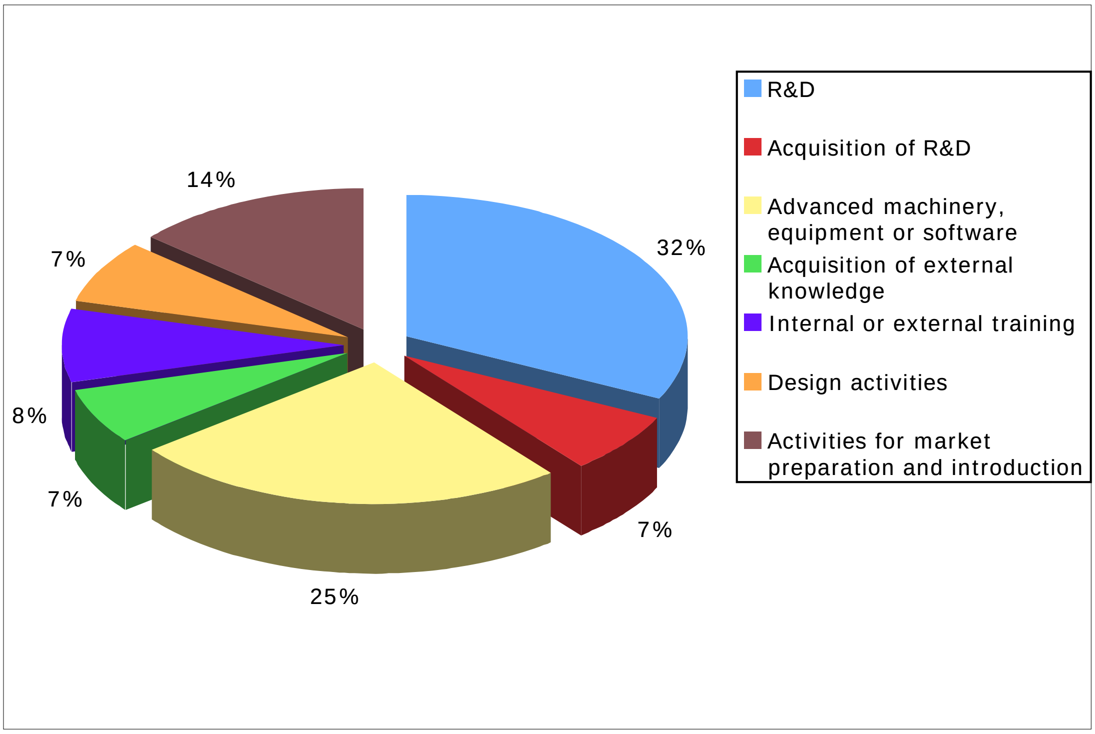


Figure 17: Innovation expenditures, information, media and telecommunications (%)

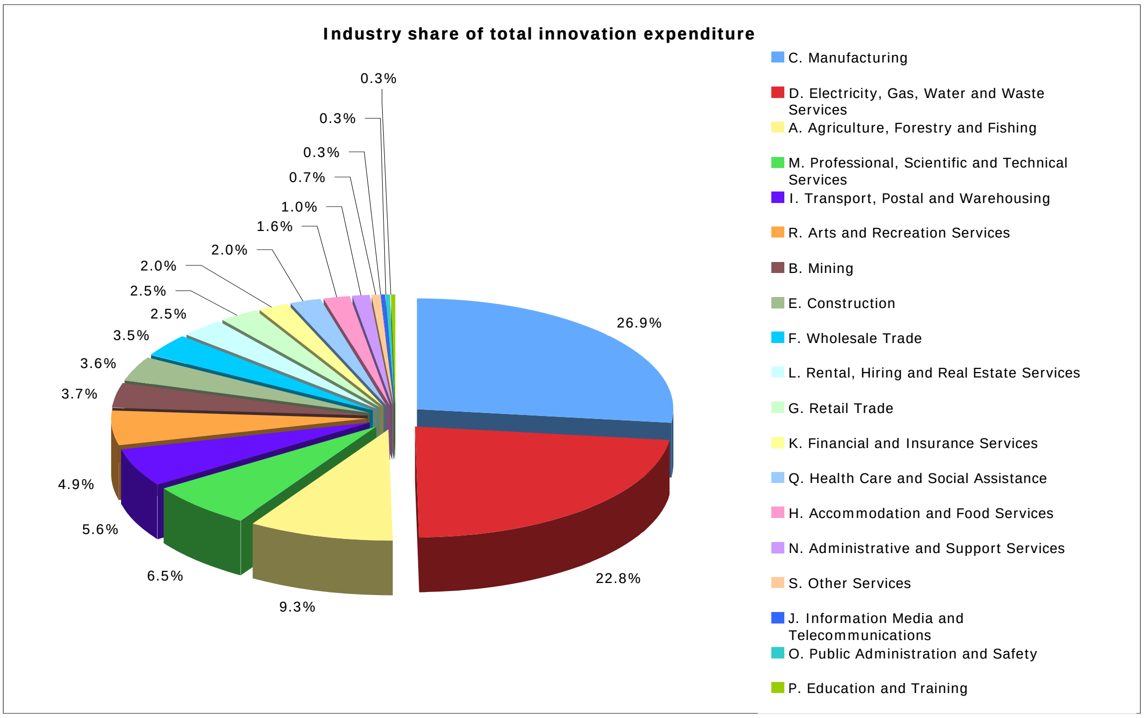


The key differences tend to lie in different proportions of R&D and capital equipment acquisition, but market preparation and training also play important roles. The policy significance of these differences lies in the fact that large parts of public innovation support - at national and also at state levels - consists of measures to promote R&D and/or support allegedly R&D-intensive activities. This seriously neglects both the complexity of investment in innovation, and in particular the central role of capital investment in the adoption of new technologies, and hence in the innovative upgrading of large so-called 'low-tech' sectors.

The distribution of innovation expenditures

Following consideration of innovation expenditure within industries, the next question might ask how total expenditure on innovation is distributed across the economy, that is, of all the money being invested in innovation related activities in the Tasmanian economy, what is each industry's significance in terms of contribution to the total?

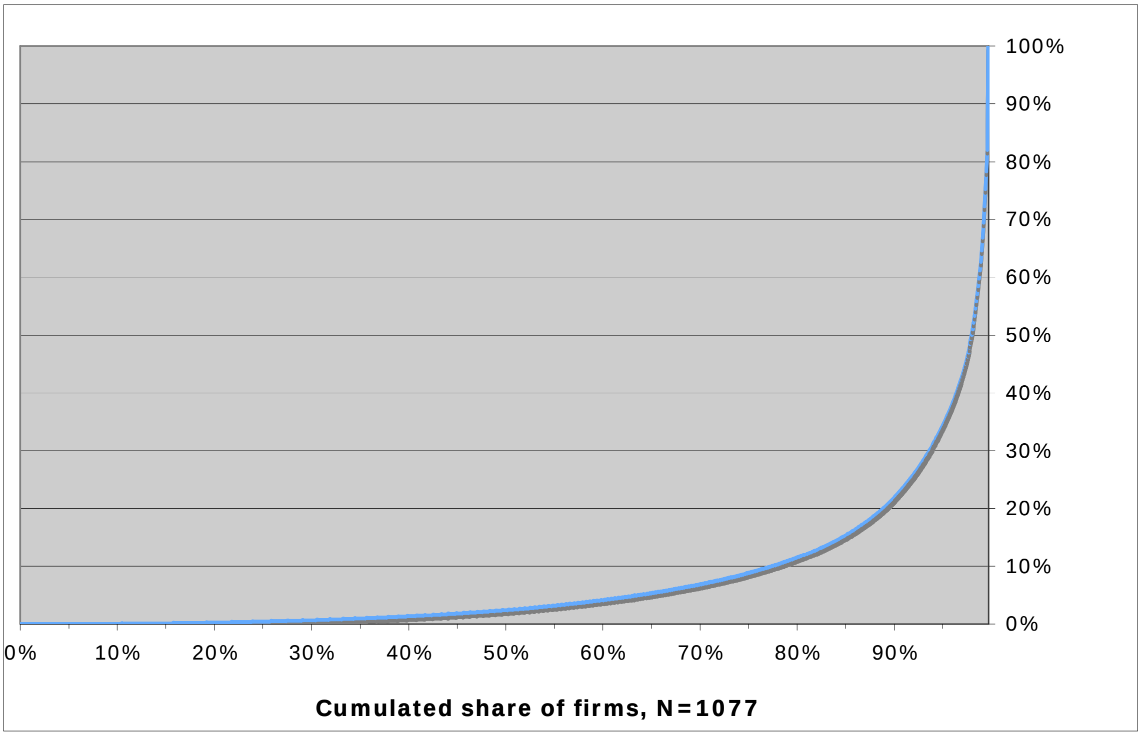
Figure 18 Industry shares of total innovation expenditure



As could be expected, industry expenditure on innovation tracks fairly closely with the overall size of an industry sector within the economy, (although a more detailed comparison of expenditure against industry size may be worthwhile). Drilling down further to look at the spread of firm contributions, and the significance of industry contributions in terms of particular types of innovation expenditure derives some interesting insights.

We noted above the extremely skewed distribution of innovation outputs across firms, regardless of the firm-size categories they were in. We argued that this skewness poses important questions for policymakers, mainly related to targeting of innovation support. The same issue applies to innovation expenditures. We constructed a cumulative distribution of innovation expenditure across all firms reporting them. It looks as follows:

Figure 19: Cumulative distribution of innovation expenditures



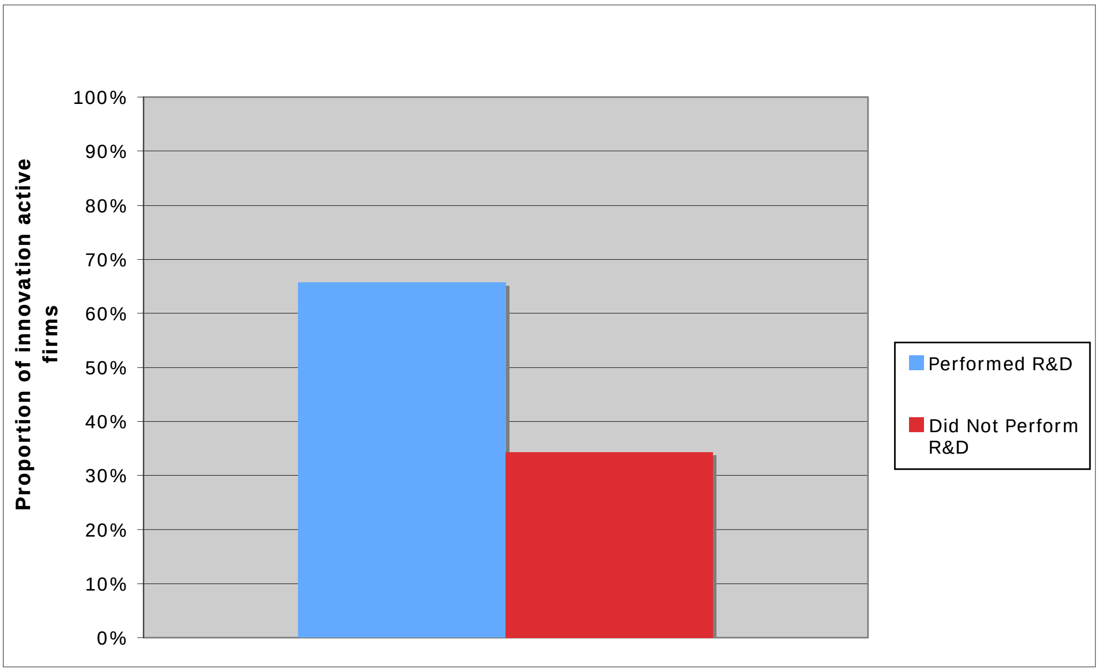
The pattern is just as uneven as the pattern of innovation sales across firms. Here, less than ten percent of the firms account for eighty percent of the innovation expenditure, roughly the same distribution as with innovative sales. To put specific numbers on it, about one hundred firms account for the vast majority of innovation expenditure in Tasmania. Once again this raises questions about policy targeting, and how policies should be balanced between low-innovation and high-innovation firms.

R&D Performance in Tasmania

We have shown that when Tasmanian industries invest in innovation they have to invest in a wide range of activities. R&D is just one of these, although it is an important one. We asked firms not only about their performance of R&D, but also about their objectives - what application areas were they aiming at - and about the scientific or technological field of research in which they are working.

The first point about R&D in Tasmania is that there appears to be a lot of it: more than sixty percent of innovating firms reported that they are doing R&D, as Figure 20 shows:

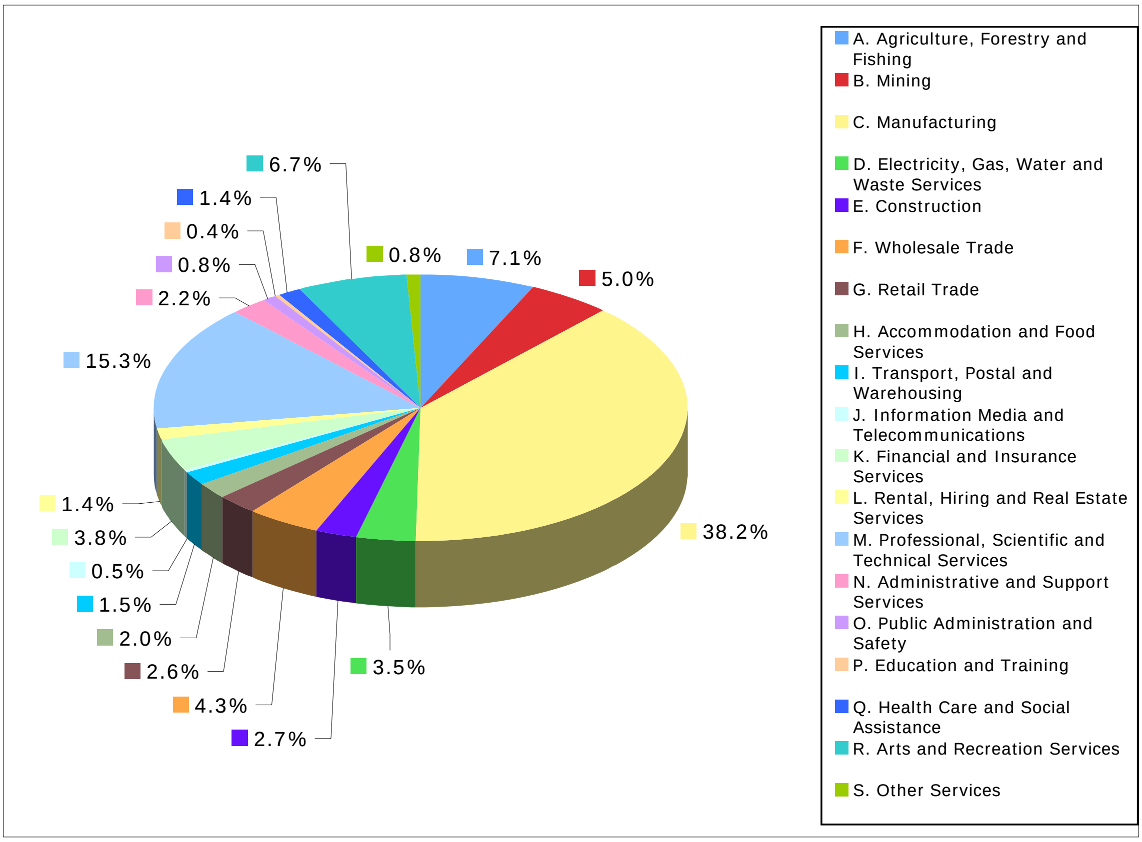
Figure 20: Innovation-active firms performing R&D (%)



This implies that more than forty percent of all firms are performing R&D, a figure much higher than indicated in ABS figures. There are various possible reasons for this. One is that firms may have varied understandings of what 'R&D' means. Another is that the ABS survey focuses primarily on firms who are performing R&D on a continuous basis, whereas we are simply asking about the performance of any R&D at all during the reference period 2004-6.

Tasmanian expenditure on R&D is distributed across all sectors, as Figure 21 indicates:

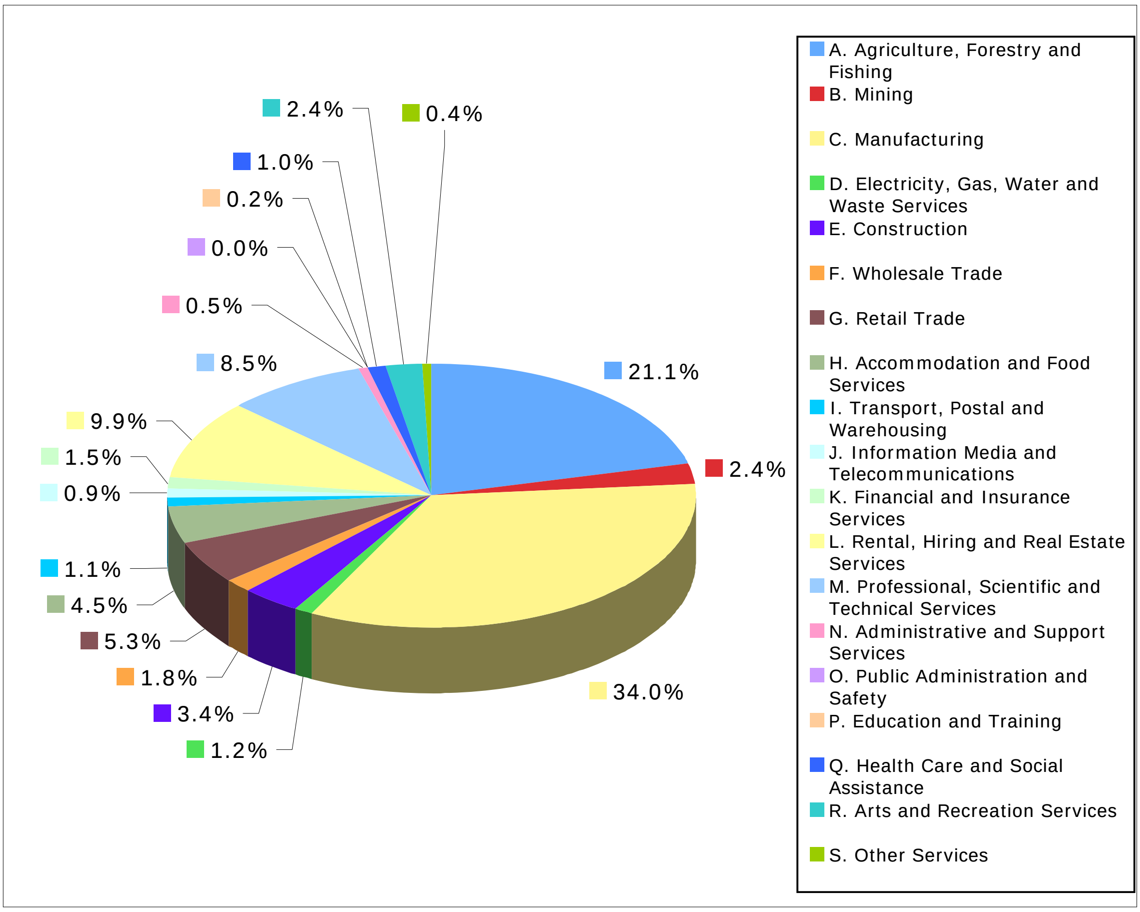
Figure 21: Industry shares of business expenditure on R&D



The really big R&D performer is the manufacturing sector, but Professional, Scientific and Technical Services is also a large sector. It is worth noting that agriculture is the third largest R&D-performing sector: this is important because agriculture is often considered deficient in terms of direct performance of R&D.

Firms not only perform R&D themselves, they buy in R&D performed by others, such as engineering consulting firms, universities and research institutes such as CRCs or CSIRO. Figure 22 shows the industry distribution of total expenditure on this acquired R&D:

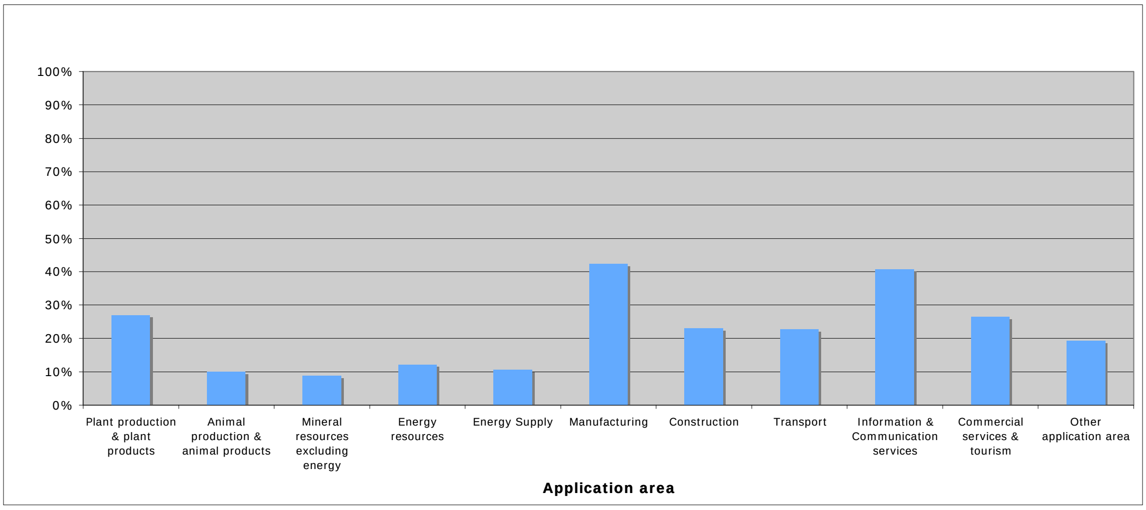
Figure 22: Industry shares of total expenditure on acquisition of R&D (%)



Fifty-five percent of all acquired R&D is bought by two sectors, namely manufacturing and agriculture. This tends to confirm the view that agriculture is a more knowledge-intensive sector than is often acknowledged, with a strong reliance on inward flows of knowledge from outside the sector.

The broad industry distribution of R&D is confirmed if we look at application areas. We asked firms to specify what is known as the 'socio-economic objective' of their R&D. This is essentially the field of economic or public activity in which results of R&D might be applied. Figure 23 shows the range of this, giving the proportion of firms reporting a particular objective (note that firms were able to specify more than one objective).

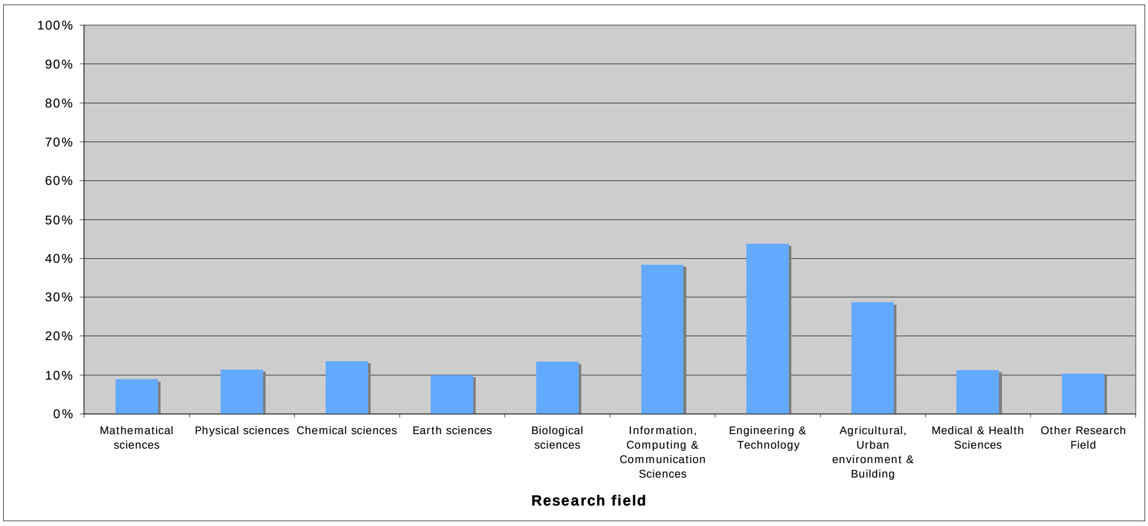
Figure 23: Tasmanian R&D-active firms by socio-economic objective



It is worth remarking here that the two largest socio-economic areas are Information and Communication Services, and Manufacturing. We shall return to the role of Information and Communication Technologies (ICT) below.

We can also classify R&D by 'Fields of Research', or the scientific and technological fields in which firms are actually researching. Figure 24 shows the proportion of R&D-active firms by these fields:

Figure 24: Tasmanian R&D-active firms by research field



Once again, there is a broad distribution of fields, but with a concentration on agricultural, urban environment and building; engineering; and information, computing and communications services. The latter leads to a question concerning the role and distribution of ICT

R&D among Tasmanian firms. It is usually argued that ICT is a ‘generic’ or ‘general purpose’ technology, with relevance across virtually all industries. Is this reflected in our R&D data? In particular is ICT R&D confined mainly to the ICT sector, or does it appear across firms in general in Tasmania?

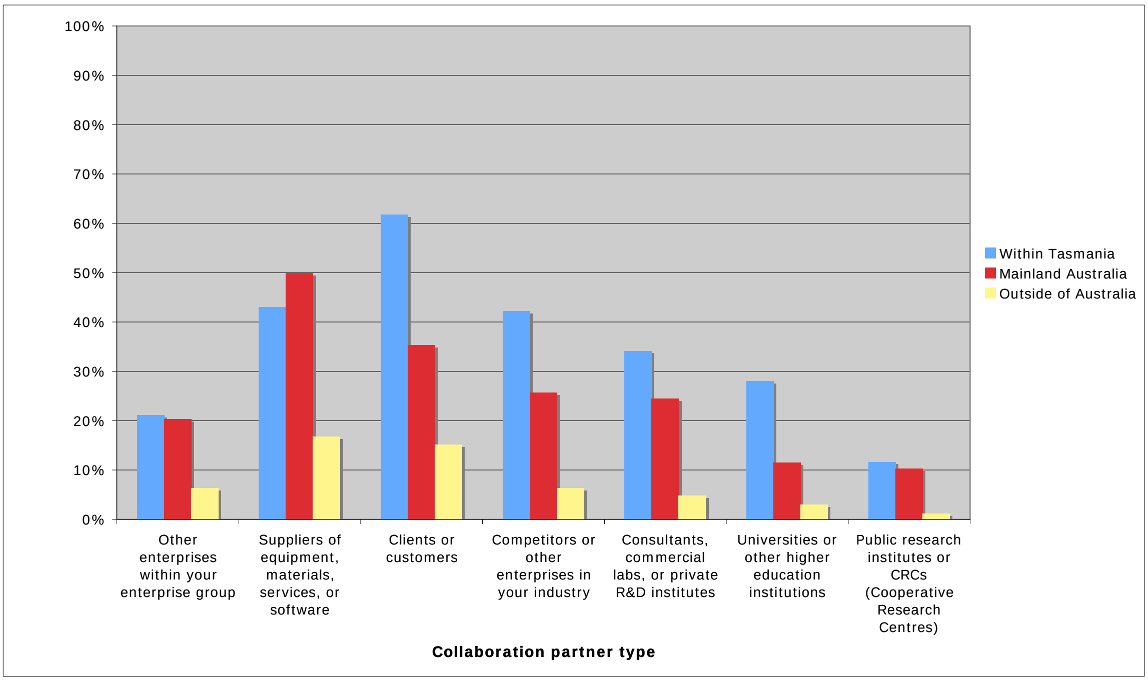
We looked at this by first defining the “ICT sector”. At a basic level we define the ICT sector in terms of two ANZSIC divisions, namely J and M (“Information, media and telecommunications” and “Professional, scientific and technical services”). Defining the ICT sector in this way gives us 179 firms in our dataset. However outside the ICT sector we have 667 firms performing R&D. Of these, 206 (or 30.9%) cite information, computing and communications services as an application area. Turning to research fields, 222 firms (or 33.3%) cite information, computing and communications services as a field in which they are researching. The conclusion of this is that more responding firms are doing information technology R&D *outside* the ICT sector than inside. So ICT does indeed appear to be an important generic technology for Tasmanian businesses.

Collaborating for innovation

Innovating firms are often collaborating firms: they link up with suppliers, customers, research institutions and even competitors collaboratively to develop new knowledge and innovative ideas. We explored this by asking firms about whether they collaborated as part of their innovation activities, if so with whom, and about the location of collaboration partners. Within our dataset 507 firms were engaged in collaboration; this was 45.5% of all innovating firms.

The results in terms of types of collaborating partners and locations of partners are summarised in Figure 25 below:

Figure 25: Collaboration by partner type and location



The overall pattern here, of collaboration primarily with customers and suppliers, with slightly lower levels of collaboration with competitors and consultants, is typical of wider innovation data results, and of the case study literature on collaboration. Most collaboration is within Tasmania or mainland Australia, but it is worth noting that overseas collaboration is present to some degree with every type of collaborative partner. This suggests a more global dimension to Tasmanian innovation collaboration than many people might suspect.

There is one unusual and striking result in this data, which is the extent of collaboration with universities, particularly in Tasmania. 142 firms (or 28% of all collaborating firms, and 12.7% of all innovating firms) reported that they were collaborating with a university in Tasmania. This must mean the University of Tasmania (UTAS). At the time of the survey, the Australian Maritime College was the only other university-level organisation in Tasmania, but has now amalgamated with UTAS. What this suggests is a much wider role for UTAS in the regional innovation system of Tasmania than might have been expected. An important task for future research will be to explore this result in more depth - what types of collaboration are under way, how are results shared, who initiates university-industry collaboration, is the university closely linked to highly-innovative firms etc? The answers here are likely to be of considerable policy significance.

What kinds of innovation? The 'Most Important Innovations'

All of the questions in the Tasmanian Innovation Census were essentially quantitative. However we also asked an open-ended qualitative question at the conclusion of the interview, asking respondents to describe in their own words their "Most Important Innovation" (MII). This question was completely open: we offered no guidelines and no definitions, leaving it up to the respondents to understand the question any way they liked, and to offer any response they wished. They could not only describe their most important innovation, but also offer comments, which we noted. This question produced results which we regard as interesting and important.

Nearly 1100 firms (that is, about 65% of all respondents) responded to this question with an applicable answer (about 400 firms gave no response or a non applicable response). The answers are often very illuminating in relation to individual responses to the survey. The fundamental problem with this kind of question, however, is how to classify the responses in order to make them comparable and hence useful at the population level.

There is no simple route towards classifying the answers, because "innovation" is a complex activity that includes technological, organisational and economic elements. It is not possible to classify by any one of these dimensions because other factors may come into play. For example, the patent classification for inventions is a set of technical functions that can be used to sort patents into technological fields. But innovation is not invention: a key point is that a new technology, service or organisation must be implemented - either by introducing it to the market or by setting it to work in a new process. This means that the economic domain of the process or final output in which it is implemented may be the relevant classification category. We also need to bear in mind that innovations may be products, processes, new forms of organisation, or new markets or marketing methods. So introducing a new form of lighting may be a product (a new lamp), part of a process change (in a workplace), or part of a product that incorporates lighting (such as a vehicle), or part of a service (such as a cinema or a car park).

The overall problem is therefore multidimensional, and any classification approach must be to some extent arbitrary. We have used two ways of classifying: a 'vertical' classification, which sorts innovations by their "industry innovation field", and a horizontal one which sorts organisational innovations that might occur across a wide range of industries. Our classification process is continuing, and we report below only on the ‘first shot’ at the classification.

The vertical approach is to classify all products and technical processes according to what we call the “industry innovation field” which is defined by the final output to which they contribute. The industry innovation field is the broad set of technologies and technical services that make up the totality of the technology of final output of an industry. So the “industry innovation fields” are in effect technologies related to the industrial structure - they broadly correspond to ANZSIC divisions (the main missing division is Public Administration and Safety). The horizontal classification divides organisational changes into two broad types: those related to business process, and those related to human resources.

There are three issues worth noting to this approach. The first concerns ICT. Where an ICT product or application is clearly being sold as a product to other firms and industries it is classified under “ICT systems, applications and services”. Where an ICT application is implemented by a firm in its organisation or processes it is classified according to the final output being produced, but in future work it will be sub-classified as an ICT input. This will enable us to produce a complete overview of ICT innovations. The second concerns any innovation that may have a beneficial environmental objective or impact: a significant number of the MIIs appear to be related to environmental challenges. These will be classified similarly to ICT: according to final output, but with a sub classification identifying it as an environmental innovation. The third will concern marketing innovations, where there will be a subcategory on “Opening New markets”. The fourth concerns Wine (an important Tasmanian product), which currently is classified under Food and Beverages, but will also be sub-classified separately.

This gives us the following broad classification of fields of innovation in Tasmania, which we continue to work with. A first important result, which is consistent with the general conclusions presented earlier in the report, is that we have MIIs in every one of the following categories. This accords with our conclusion that innovation in Tasmania is extremely broad in character, relevant across the whole span of economic activities, and taking multifarious forms.

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Table 3: Classifying most important innovations

Most important innovations	
Industry innovation fields	**Relevant ANZSIC Division**
Agricultural and horticultural products and technologies	A
Power generation and transmission	D
Transport equipment (including air and maritime) and services, packaging and logistics	I, F
Manufacturing and workshop processes (inc. machinery improvements and upgrading)	C
Tourism, hospitality, leisure products and services (includes restaurant and café technologies)	H, R
Construction/building technology including interior design and furniture	E
Financial, business, design and property services;	K, L
ICT systems, applications and services	J
Textiles, Clothing and footwear	C
Forestry, timber, pulp, paper and related technologies	A
Aquaculture and fishing products and technologies (including new species)	A
Food and beverage products and processing Sub category: wine	A
Health products and services (inc. child and aged care)	Q
Printing and publishing; advertising; media	J
Mining and metals	B
Environmental and Research services	M
Organisational innovation fields	
Business processes, models and services (Includes premises/infrastructure, work organisation and management practices)	N, O
Human resources, training, education and skill development, occupational health and safety	P, O
Marketing innovations	
Retail and Customer services and marketing Sub category: opening new markets	G

In the following table we simply present a count of different types of MII using a somewhat simplified version of the structure above. Again we emphasize: this is the ‘first shot’ and will be subject to revision in later work, as we develop the sub-classifications. However we do not expect the basic structure to change.

Table 4: Counts of most important innovations

Agriculture, horticulture, aquaculture, food and beverages	150
Natural resources and environment	62
Human resources; business processes	212
Business services	42
Customer services, retail and marketing	120
ICT products and services	106
Health	41
Power generation/transmission	8
Tourism & leisure	73
Transport products and services	86
Manufacturing products and processes	81
Construction	83
Printing, media	20
Non-innovators, other, or NA	434
Total	1518

There are a number of very noteworthy points about this. The first is that by far the largest single area of innovation concerns ‘soft’ innovations such as human resources, skills and training and business processes (business planning, strategy development etc). Within the ‘soft’ area, skills, staff training, and so on were very often mentioned by firms as their big priority and their most important area of innovation. This is a much more important area of public policy for innovation than is often recognised. Secondly, the overall ‘food complex’ is very important in Tasmania. This extends from agriculture and horticulture, to food processing, to food retailing, to restaurants and cafes. This is clearly a big and very differentiated area, but is unified by the food focus, and is of great importance in Tasmania both economically and as an innovation area. Thirdly, ICT is very important. We noted above that many ICT innovations are not counted here, because when an innovation in, say, printing involves ICT we counted it within printing and media. If a food firm began web marketing we counted that as a food innovation. What is counted here as ICT is primarily hardware and software that is being sold as an ‘arms length’ product? Even so this is large, and if we take it together with the ICT component of other innovations, it is clear that the effects of the ICT revolution are far from over in Tasmania.

Conclusion

The Tasmanian Innovation Census has generated two major research assets, namely a database of all firms with 5 or more employees in Tasmania, and a large dataset on the innovation activities of firms responding to the census. What we have presented here is simply the first overview of the data results. There are very many detailed research opportunities with the data that are underway, or will be developed in the future that will occupy researchers for some years into the future.

Even this broad overview of results contains some surprises which are important not only for understanding Tasmania, but for the development of policies by the Tasmanian Government. The idea that Tasmania is not an innovative place must be firmly rejected: it has highly innovative activity across all industries, across all major technologies, across all R&D fields, and across the whole gamut of innovation-related investment. Firms in Tasmania invest in skills, capital goods and R&D for innovation, and they collaborate extensively with the science base, mainly in the form of the University of Tasmania - but they also collaborate nationally and indeed globally with firms and knowledge institutions. The central problem for the future is that although the vast majority of firms are innovation-active, only a small minority appear to be intensively innovative. The base of firms who invest heavily in innovation, and who have large proportions of innovative products in their sales mix, is very narrow. This is a challenge for policymakers in Tasmania.

There is much we will be able to learn from the future use of this data. The Australian Innovation Research Centre is already researching the role of ICT in Tasmanian innovation structure, innovation in a specific locality (the Coal River Valley), the relationship between innovation and logistic planning for Tasmania, and innovation and the skills and training system. We will go on to look at university-industry interactions, the geographic (locality) implications of innovation in Tasmania, food industry innovation, the detailed structure and content of the 'most important innovations' reported by firms, and the links between innovation and firm performance.

Through the Innovation Census project the AIRC has created an information and analysis resource for policymakers and the public in Tasmania that is unique, not only in Australia but in the world. We hope that it will contribute to the work of Government and to public discussion and debate in the coming months and years.